Basics of numpy and matplotlib

Software 1 and Software 2 – Python Labs for Math and Physics

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Numpy – numerical python

- Numpy is the core numerical computing library for Python.
- It is used almost every field of science and engineering.
- Several other libraries, like scipy, pandas, scikit-image, scikit-learn, and tensorflow are based on it.

Numerical array structure

The core of numpy is the **numerical array** data structure (numpy.array)

- Other Python structures (lists and tuples) can be converted to numpy arrays.
- There are special functions that generates and creates numpy arrays.
- Arrays can be replicated, joined, edited, read and write to files in standard and custom formats.

Basic array creation

```
import numpy as np

# Convert a list to an array
x = np.array([1, 2, 3, 4])

# Create a range of numbers
x2 = np.arange(1, 5, 0.1)

# Create equally spaced array
x3 = np.linspace(1, 5, 20)
```

Array creation — NumPy v1.23 Manual

Basic array creation (2/2)

```
import numpy as np

# Array of zeros
x0 = np.zeros((1, 10))

# Array of ones
x1 = np.ones((1, 10))
```

Array creation — NumPy v1.23 Manual

Array numerical operations

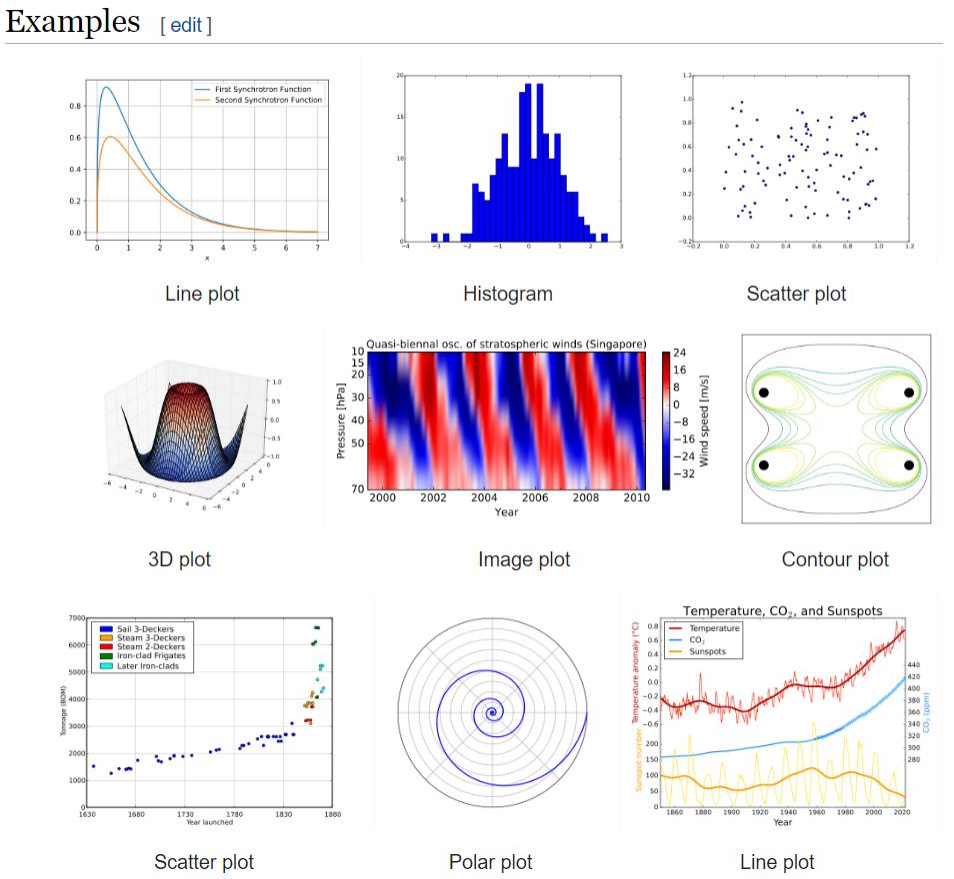
```
# Create a range of numbers
x = np.arange(1, 10, 1)

# Calculate a value of a function
y1 = x + 2

# Another function and it's values
y2 = x**2

# Combining arrays
y = y1 + y2
```

Array creation — NumPy v1.23 Manual

Matplotlib – plotting library for Python

Matplotlib is the foundation for several other graphics libraries for Python

- It's *object-oriented syntax* give control over almost all graphical features.

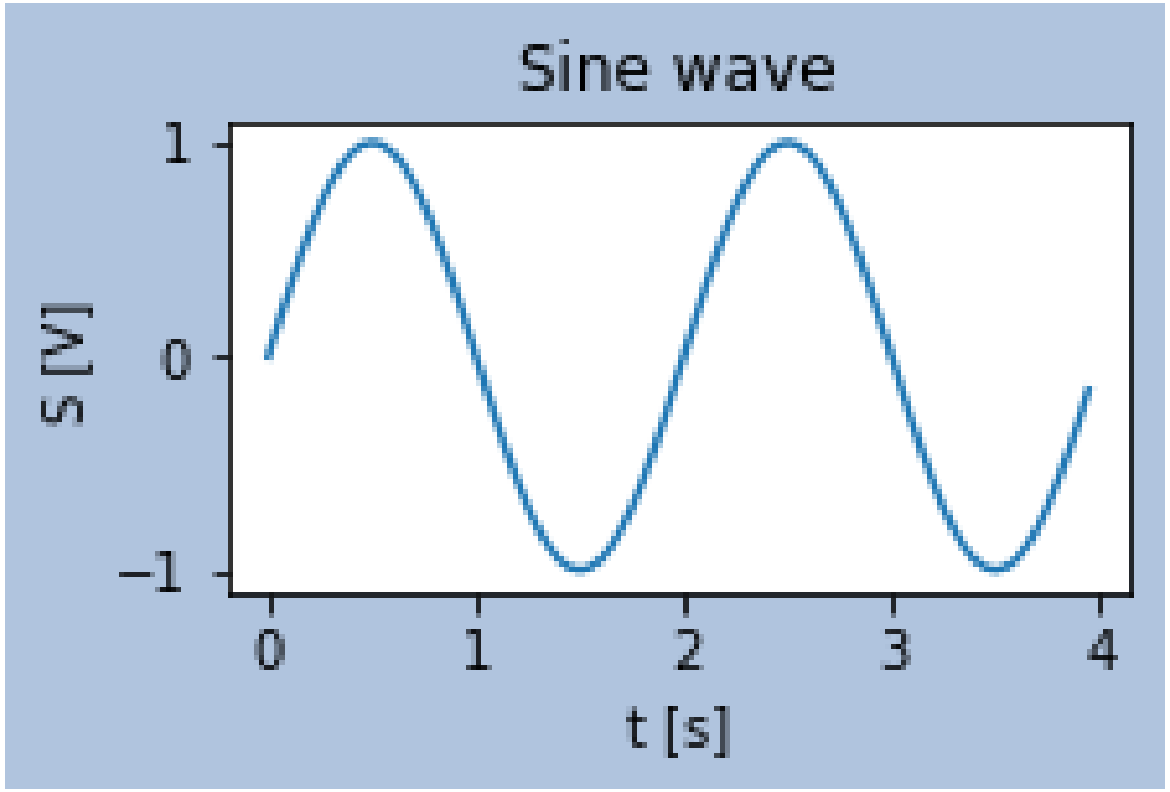


[API Reference — Matplotlib 3.5.3 documentation]

[Matplotlib - Wikipedia]

Draw a first plot - example

```
import matplotlib.pyplot as plt
import numpy as np

x = np.arange(0, 4, 0.05)
y = np.sin(x*np.pi)

fig, ax = plt.subplots(
   figsize=(3,2),
   constrained_layout=True)
ax.plot(x, y)
ax.set_xlabel('t [s]')
ax.set_ylabel('S [V]')
ax.set_title('Sine wave')
fig.set_facecolor('lightsteelblue')
```



[Getting started — Matplotlib 3.5.3 documentation]

Pyplot – MATLAB like graphical functions

Matplotlib.pyplot is a collection of functions that make some changes to a figure

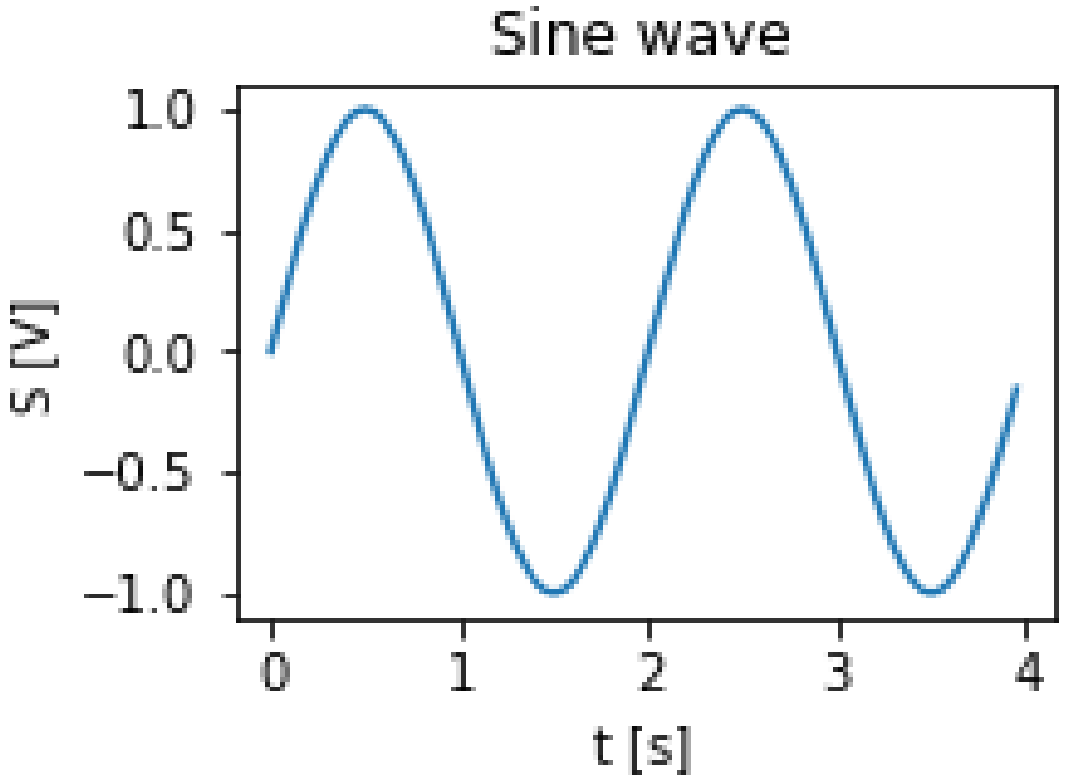
- Creates a figure
- Creates a plotting area in a figure
- Plots some lines in a plotting area
- Decorates the plot with labels, etc.

The *pyplot API* is simpler than the object-oriented API, but less-flexible.

Pyplot tutorial — Matplotlib 3.5.3 documentation

Draw a first plot with pyplot API

```
import matplotlib.pyplot as plt
import numpy as np

x = np.arange(0, 4, 0.05)
y = np.sin(x*np.pi)

plt.figure(figsize=(3, 2))
plt.plot(x, y)
plt.xlabel('t [s]')
plt.ylabel('S [V]')
plt.title('Sine wave')
```



Next steps

- Practice – Lab 1
  - OMA > Assignments
    - Notebook for JupyterLab
  - Moodle workspace
    - Automatic checking and testing your code
- Read more
  - Numpy v1.23 manual
    - NumPy: the absolute basics for beginners
    - NumPy fundamentals
  - Matplotlib 3.5.3 documentation
    - Basic Usage
    - Pyplot tutorial